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Doping characteristics for WS_xSe_y Monolayer

The transition metal dichalcogenides (TMDs) have attracted much attention because its unique characteristics and potential application in the low-power and optoelectronic devices. Recent reports have successfully demonstrated the growth of 2-dimensional MoS_xSe_y, WS_xSe_y, $Mo_xW_yS_2$ and $Mo_xW_ySe_2$ alloys, where these materials exhibit tunable band gap energies. However, few literatures focus on the doping behaviors in those 2D monolayer alloys. In the study, we report that WS_xSe_y monolayer alloys were synthysized using tungsten oxides, selenium and sulfur powders as the sources in the CVD process, where different heating temperatures of selenium and sulfur powders are applied respectively for controlling the ratio of S to Se. The optical band gap of the as-grown WS_xSe_y monolayer alloys from 2.0 eV to 1.64 eV is precisely tunable via the different chalcogenide heating temperature. With the increase of selenium in WS_xSe_y monolayers, apparent electronic state transform from p-type to n-type were recorded through energy band diagrams, beneficial for the future optical design.

References

[1] Yung-Huang Chang, Wenjing Zhang, Yihan Zhu, Yu Han, Jiang Pu, Jan-Kai Chang, Wei-Ting Hsu, Jing-Kai Huang, Chang-Lung Hsu, Ming-Hui Chiu, Taishi Takenobu, Henan Li, Chih-I Wu, Wen-Hao Chang, Andrew Thye Shen Wee, Lain-Jong Li, *ACS Nano* **2014**, 8, 8582–8590.

Figures

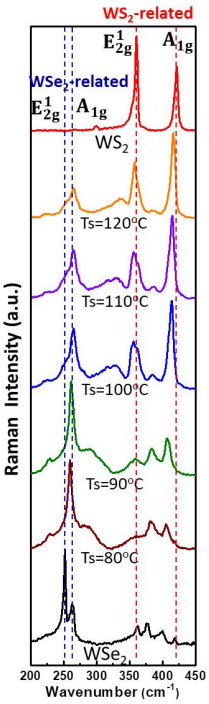

Figure 1: Raman spectra of pristine WS_2, WSe_2 and as-grown WS_xSe_y monolayers. The WS_2-related Raman characteristic peaks, A_{1g} and E^1_{2g}, of the as-grown WS_xSe_y monolayers were a blue shift because of the change of carrier concentration toward n-doping. Meanwhile, redshift for WSe_2-related Raman peaks may result from the change of carrier concentration toward p-doping.